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BACTERIAL WILT AND WINTER INJURY OF ALFALFA

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INTRODUCTION

During the last three or four years serious injury of alfalfa, apparently resulting from two very distinct causes—bacterial wilt and winter injury—has attracted increasing attention in many alfalfa-growing regions of the United States, especially in the central part of the Mississippi Valley. Both types of injury are widely distributed, and wherever they occur together they tend to be increasingly responsible for the comparatively early thinning out and death of alfalfa. This circular contains a brief description of the symptoms and the progressive stages of the development characteristic of these types of injury and suggests control measures, which, it is hoped, may in some degree reduce the alfalfa losses.

Bacterial wilt and winter injury are of widely different origin and character. Bacterial wilt is caused by parasitic bacteria, which enter the plant through wounds and multiply in the water-carrying vessels and in some of the soft tissues of the upper part of the root and crown until the plant is killed. In winter injury, on the other hand, young shoots developed in the fall ready for growth in early spring are killed or injured, and the taproot itself may be damaged so that the life of the plant depends largely upon its ability to heal the wounds completely and rapidly. Inasmuch as it is often of the utmost importance to distinguish between these two types of injury, the chief characteristics of each are emphasized in the following descriptions:

BACTERIAL WILT

Although bacterial wilt is primarily a disease of the underground part of the plant, shortly before the plant dies the disease produces characteristic evidence of its presence in the stems and leaves. Occasionally plants wilt during hot weather of the spring or summer and die immediately, somewhat in the manner of plants whose roots have been severed by gophers. More frequently the plants do not wilt, but usually show before they die a characteristic dwarfed

condition. (Fig. 1, A.) The stems are more or less shortened and may appear to be increased in number; the foliage is usually pale green or yellow; the leaves are frequently very small and their edges often become brown in hot weather; and after each succeeding cutting the new stems produced are usually much shorter until the plant dies altogether. This yellowing and dwarfing of the foliage are quite unlike those caused by any other disease of the alfalfa plant, and when they are present the disease is recognized easily. However, plants often live a year or more after becoming diseased before that fact is revealed by the appearance of their foliage. During this year the bacteria spread slowly in the crown and root, where they always produce a yellow discoloration that can be easily seen when the root is dug and cut open. The upper end of the taproot close below the crown is the best place at which to search for the discoloration caused by the bacteria. When the root is cut across, the discoloration is found in the wood just beneath the bark. (Fig. 1, B.) It may form a complete circle whose width depends largely upon the length of time the disease has been present. If infection is recent, discoloration may be very slight and small in extent, and in such cases it is usually seen best by stripping back the bark from the root and exposing a yellow stain, which extends down the root in broad streaks.

In badly diseased plants the bark separates easily from the wood, which is yellow and often slimy for a foot or more below the crown. Sometimes when plants are collected in late summer the diseased wood is overlaid with a thin layer of new white wood, which must be removed in addition to the bark before the yellow diseased wood is exposed. A yellow discoloration of the outer wood of the root, at first slight, but ultimately extending far down the taproot and into the larger branch roots, characterizes this disease.

WINTER INJURY

The term "winter injury" as used in this circular refers to damage of buds, crown, and root of the alfalfa plant comparable to the injury inflicted by low winter temperatures upon similar parts of fruit trees. In the past, winter injury of alfalfa has referred commonly to the injury of alfalfa stands resulting from the winter killing of many of the plants. Such injury of fields is more appropriately called winterkilling, and the term "winter injury" is better applied to the freezing injury suffered by individual plants.

Although in the extensive writings about alfalfa the injuries that the plants show in the spring resulting from winter cold are rarely mentioned, in regions where low temperatures find the plants unprotected by snow or where some winter killing has occurred such injury can often be found very abundantly on surviving plants. Some of the injury is by itself relatively inconspicuous and unimportant in its effect upon the future development of the plant, but injury at the base of the crown or on the root often becomes conspicuous and shortens the life and diminishes the vigor of the stand. Oftentimes shoots develop so far in the fall that their bases are injured in the winter so that they either die or are greatly weakened. Such injury is not conspicuous or important provided a sufficient number of buds remain uninjured. The killing of buds at the base of the crown



FIG. 1.—Bacterial wilt of alfalfa. A, comparison of a diseased with a healthy alfalfa plant. Four-year-old plants grown at Manhattan, Kans. The diseased plant at the left shows the dwarfed stems and pale leaves characteristic of the disease when the plant is nearly dead. B, enlarged cross section of a 3-year-old alfalfa root in which the disease has been developing during the third year of its growth. The dark color in the outermost circle of wood close beneath the thick bark shows the region in which the bacteria have invaded the root. This dark color in the photograph was yellow or brown in the freshly cut root. The position, as well as the character of this discoloration, is very different from that occurring in winter injury shown in Figure 2. C, cross section of a healthy root of same age as the diseased root shown in B.

is one of the most common and easily overlooked forms of winter injury. It occurs in plants of all ages. Frequently not only the buds but also the tissue from which new buds may arise (fig. 2, B and C) are killed, and in consequence buds developed after this injury come from a higher position on the crown.

The most conspicuous and perhaps the most serious injuries that result from the action of frost are found in the upper part of the taproot. Two regions of the root are usually damaged or killed more easily than the rest. These are located at the center and in the bark. Injury at the center of the root is shown by a shrinking of the wood and the opening of cracks along which blackening and decay follow sooner or later. (Fig. 2, E.) A hollow root results. Injury in the bark may cause rapid decay of the outer bark of older plants, or a gradual browning and peeling of the outer bark of younger ones. (Fig. 2, B and C.) A thin inconspicuous layer of new bark is always produced beneath the old to protect the root, but this often cracks when the plants grow vigorously, thus exposing the inside of the root to decay. In addition to the browning or blackening at the center of the wood and in the bark, a discoloration of a few fibers or rarely a wide band of wood close beneath the bark (fig. 2, D) is found.

Injury in the root or crown may be distributed uniformly around the root, or may be located chiefly on one side, causing deformities of various kinds as the plant grows. In a previous circular¹ some of the diseased conditions of alfalfa plants resulting from winter injury have been described as collar rot, and heart rot, both of which appear to be consequences of winter injury.

COMPARISON OF BACTERIAL WILT AND WINTER INJURY

In the foliage, bacterial wilt produces in the late stages of its development a conspicuous yellowing and dwarfing that distinguishes it from all other diseases. Winter injury does not at any time produce any characteristic appearance of the foliage whereby it may be recognized. It may result in the weakening and ultimate death of many of the plants, thereby causing the stand to become thin. Severely winter-injured plants may wilt and die in the spring like those infected by bacterial wilt. In such cases the root must be removed from the soil and examined before the cause of the trouble can be determined.

In the root, the discolorations produced by winter injury and wilt are different in character and in location. Bacterial wilt discolors the outer portion of the woody cylinder of the root. At first this discoloration appears as pale-yellow streaks seen when the bark is stripped from the wood. Later the entire outside of the wood is yellowed. Occasionally this yellow region is overlaid with white wood, but the discoloration remains in definite circles. Winter injury produces discoloration at the center of the wood and in the bark. Sometimes in the outer wood it produces discoloration like that of wilt, but this does not extend far down the root from the crown and is darker in color and often appears in narrow streaks.

¹ WEIMER, J. L. OBSERVATIONS ON SOME ALFALFA ROOT TROUBLES. U. S. Dept. Agr. Circ. 425, 10 p., illus. 1927.

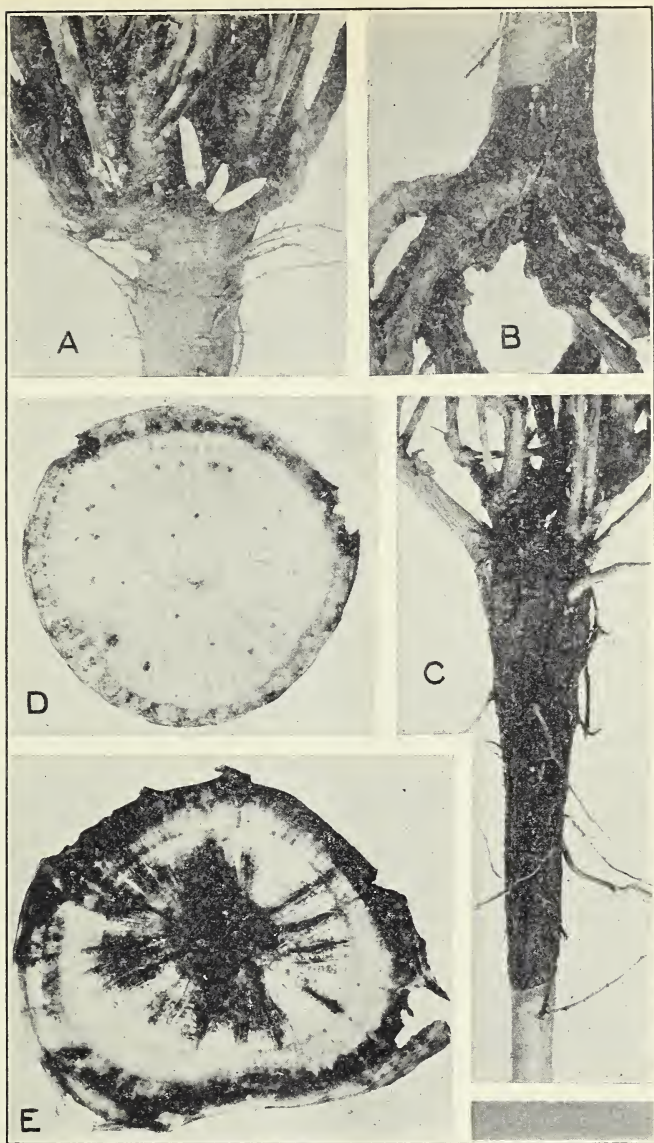


FIG. 2.—Winter injury of alfalfa. A, the crown of an uninjured alfalfa plant grown at Madison, Wis., as it appeared at the end of its fourth summer. B, crown of an injured plant found growing in the same field with that shown in A. The injury took place during the preceding winter. Note that the injury is so severe that no buds have developed from the lower part of the crown to furnish vigorous shoots for the following spring growth. C, upper part of the root of an alfalfa plant, severely injured during its first winter, as it appeared at the end of its second summer. The root is hollow and, like that shown in B, lacks fall buds at the base of the crown. D, cross section of an alfalfa root injured by cold during its second winter. Injury is chiefly in the bark. The black spots located in a circle in the outer part of the wood are also due to winter injury. E, alfalfa root similar to that shown in D injured both in the wood at the center and in the bark. A hollow root results from this type of injury.

Likewise, winter-injured roots usually show some roughening or splitting of the bark, which is never seen in plants affected by bacterial wilt alone. Thus, by examination of the taproot it is possible to distinguish the character of the injury at all stages of development even when both kinds of injury occur in the same plant.

RELATION BETWEEN BACTERIAL WILT AND WINTER INJURY

Some of the most destructive outbreaks of bacterial wilt observed thus far have occurred in fields where the plants have suffered severe winter injury. The reason for the rapid destruction of stands of alfalfa by wilt following winter injury appears to be that the bacteria find winter-injury wounds favorable points of entrance. Such wounds are often abundant; they occur in the spring when the bacteria are washed in greatest numbers from old diseased plants, and they occur in the part of the root situated near the surface of the soil where frequent rains may keep the wounded tissue wet and in favorable condition for infection. After entering the plants the bacteria may develop so slowly during the current season that few plants show conspicuous foliage symptoms of disease until the following summer. This apparent relation between winter injury and bacterial wilt is stated here because it must be taken into account in devising measures whereby the bacterial disease may be controlled.

It must be remembered, however, that, although these wounds following winter injury furnish a convenient, and perhaps the most frequent point of entrance for the bacteria that produce wilt, openings produced by other agencies such as insects, mowing machines, and cultivation may also allow the bacteria to enter the plant; and hence the bacterial disease may spread to some extent in the absence of winter injury.

CONTROL OF BACTERIAL WILT

Although alfalfa fields do not ordinarily suffer much from bacterial wilt during the first year or two, as high as 75 per cent of diseased plants have been seen in 1-year-old stands. The disease usually begins to appear in scattered spots in the fields during the second summer and continues to spread, so that frequently by the end of the third to the fifth year the stand is no longer worth maintaining in sections of the country where the disease is very prevalent. The earlier the disease destroys the stand the greater the loss to the grower.

Inasmuch as the life history of the bacteria causing the wilt disease of alfalfa is not completely known, it is not possible to indicate control measures that will completely exclude or eradicate bacterial wilt from alfalfa fields. However, from such knowledge as has been gained from observation of the spread of the disease in infested localities, it appears that the adoption of certain farm practices will reduce the damage it is causing. The source of the bacteria causing disease appears to be chiefly diseased plants living in the field. Even before a plant shows conspicuous evidence of disease, the bacteria may be distributed in almost all parts of its roots and foliage, though not, so far as has been discovered, in its seed. Thus the bacteria may be carried from diseased to healthy plants in a field by the knives of the mower. Distribution in this manner may be reduced by

mowing the field when the plants are free from dew or rain. The bacteria may be carried alive in dry fragments of stems for many months. Therefore these disease-carrying stems should not be carried to new fields either mixed with uncleaned seed or mixed as unrotted refuse from alfalfa hay with manure.

The most destructive outbreaks of bacterial wilt that have been observed in fields during the second, the third, or even the fourth summer have usually occurred in fields so situated that the bacteria washed from diseased plants in an old field could be conveyed to them by water flowing along the surface of the ground or by temporary flooding. Apparently loss of young stands can frequently be avoided by placing them where surface water can not convey the parasitic bacteria to them. Therefore, to avoid early destruction of young stands in an infested district the following measures are suggested:

New seedings of alfalfa should not be made in fields that receive surface drainage or flooding from land on which diseased plants are located.

New seedings should not be made on fields until all plants that have survived from a former diseased stand have been killed out.

In localities where the protection of new seedings from those that contain disease is impracticable, or where the disease is severe and persistently enters young stands in spite of such protection as can be given, it may be necessary to resort to the eradication of old infested stands before new plantings can be made with profit.

CONTROL OF WINTER INJURY

Winter injury appears at present to be essentially a milder phase of the climatic injury to alfalfa that in more extreme form results in winterkilling. Its control must therefore be sought in the use of hardy and adapted varieties and in farm practices that have locally demonstrated their efficiency in averting winterkilling. It is hardly possible here to discuss the merits of varieties or to describe the cutting practices recommended by agronomists. Our present interest in winter injury is derived chiefly from its relation to bacterial wilt as outlined in these pages. In view of this relation, the question arises whether the best hardy and adapted varieties escape injury to such a degree that they may be depended upon to escape bacterial wilt also. In answer to this question it must be stated that from observations made thus far it appears that hardy and adapted varieties that may survive injury in unfavorable winters and recover in a satisfactory manner when the parasitic bacteria are absent do not escape injury altogether, and they sometimes appear to be as easily invaded and destroyed by the parasitic bacteria as the more severely injured nonhardy varieties. Thus, while under some conditions the use of hardy varieties may permit many plants to escape disease, this result does not always follow, especially when sources of infection are abundant.

SUMMARY

Bacterial wilt and winter injury appear to cause a large part of the early dying out of alfalfa fields in many alfalfa-growing regions of the United States.

Bacterial wilt is caused by parasitic bacteria, which enter through wounds in the root and crown, causing a plugging of the water-carrying vessels, and bring about the death of the plant.

Winter injury results in the killing of buds and of parts of the root and crown of the alfalfa plant during the winter.

Winter injury causes wounds through which the bacteria producing wilt may easily enter if they are present in a field. Thus fields are often destroyed by bacterial wilt after they have been injured during an unfavorable winter.

From what has been learned thus far of the life history of the bacteria producing wilt, it appears that of the several possible methods that may aid in the control of the wilt disease the most important is probably the prevention of the conveyance of the bacteria by water from old diseased plants to young fields, especially in the spring when many plants have wounds through which infection may take place readily. Care should also be taken to avoid carrying the bacteria to new fields in fragments of stems of diseased plants with uncleaned seed or with manure. If the disease is present in a field, its distribution by the knives of the mower can probably be avoided to some extent by mowing when the plants are free from surface moisture.

Hardy varieties of alfalfa are often injured sufficiently during the winter to make infection with bacterial wilt possible, even though the injury by itself may cause little permanent harm to the stand. Therefore the use of hardy varieties does not always prevent, though it may reduce, loss from this disease.

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